Space Weather Research and Forecasting in CRL, Japan

Maki Akioka

Hiraiso Solar Observatory

Communications Research Laboratory

Contact akioka@crl.go.jp

Contents of Presentation

1. Space Weather Observation and Forecast in CRL
2. Status of L5 mission Study
3. Small Satellite Experiment in CRL and Space Weather
4. NASDA Space Environment Measurement
5. GEDAS Program in STEL

1. Space Weather Observation and Forecast in CRL

Construction of Space Weather Forecast Center

Data from Solar-Terrestrial Environment

Real-time collection

Installation

R&D for Space Weather

Forecast Center

Customers

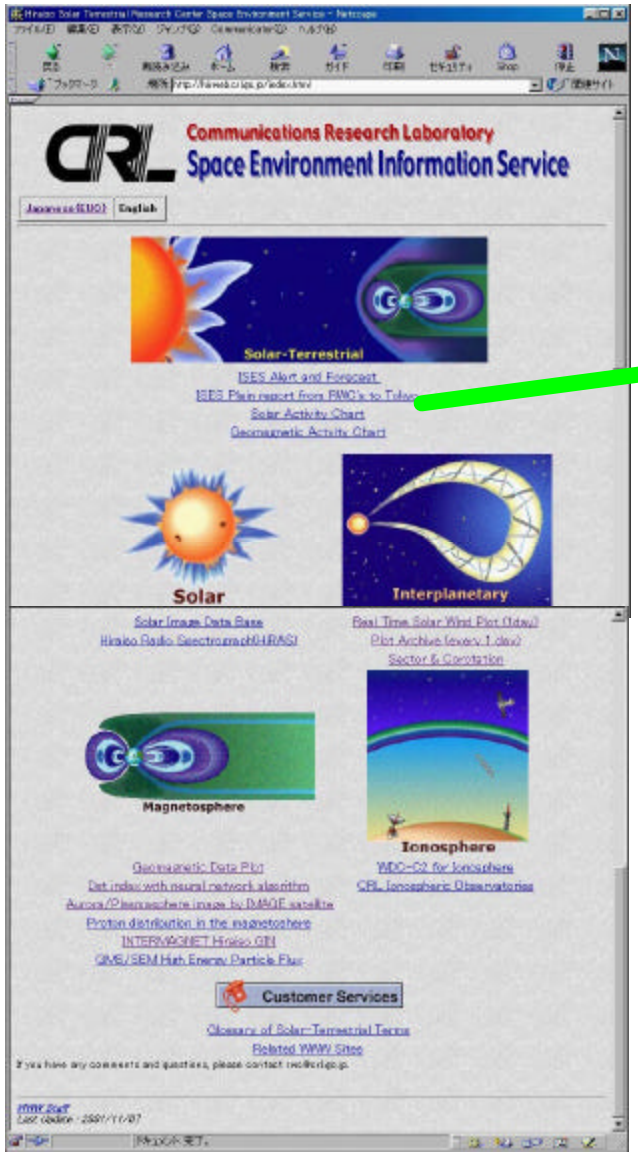
Broadcasting Information

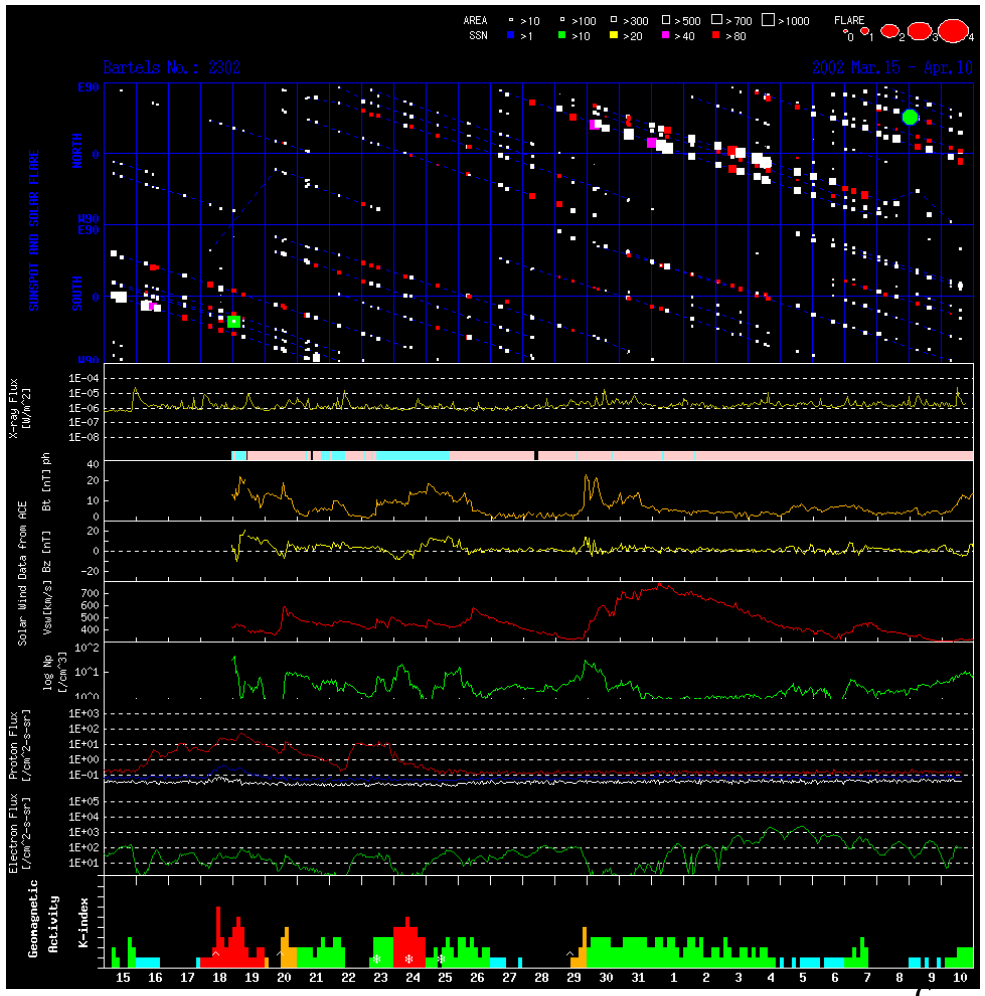
Constructing forecast center is necessary for prediction of space weather disturbances based on large amount of solar terrestrial data. We are operating this center as testing phase. Reliable forecast information will be provided for customers by installing new data and forecasting scheme from

Forecast Services

- GEOALERT (Solar flare, Geomagnetic disturbance(Storm), Proton event)
- Telephone service [7 sites in Japan]
- Space weather report (by FAX, E-mail, WWW)
- Weekly forecast for short wave propagation (by WWW)

Space Environment Information Services (http://hirweb.crl.go.jp/)





Important Issue for Space Weather in CRL

[Sun & Solar Wind]

Solar Flare & CME — Optical & radio observations, L5 mission

[Magnetosphere]

Convection — HF radar & magnetometer networks

Storm & Substorm — MHD simulation

Radiation belt — Empirical Model

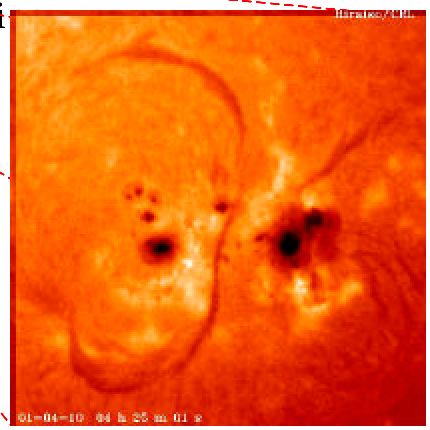
[Ionosphere]

Ionospheric Storm — Optical & radio observations

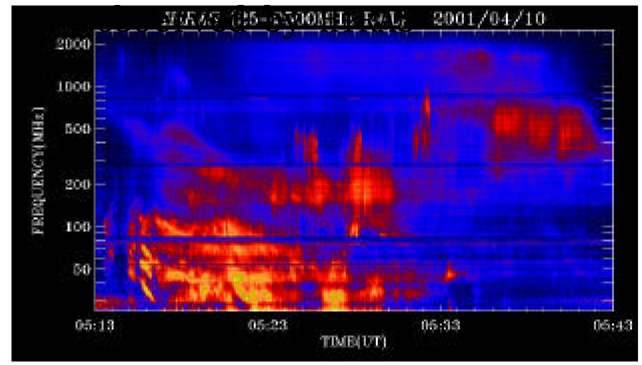
Ionospheric Scintillations — Radio observation network

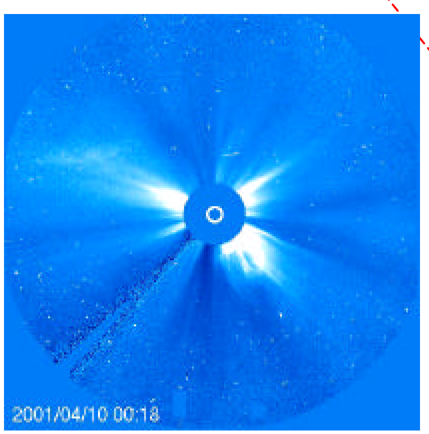
Solar observations by optical & radio telesc

Solar flare obsered by the H-alpha telescope at Hirai



Type II,III,IV of solar radio bursts

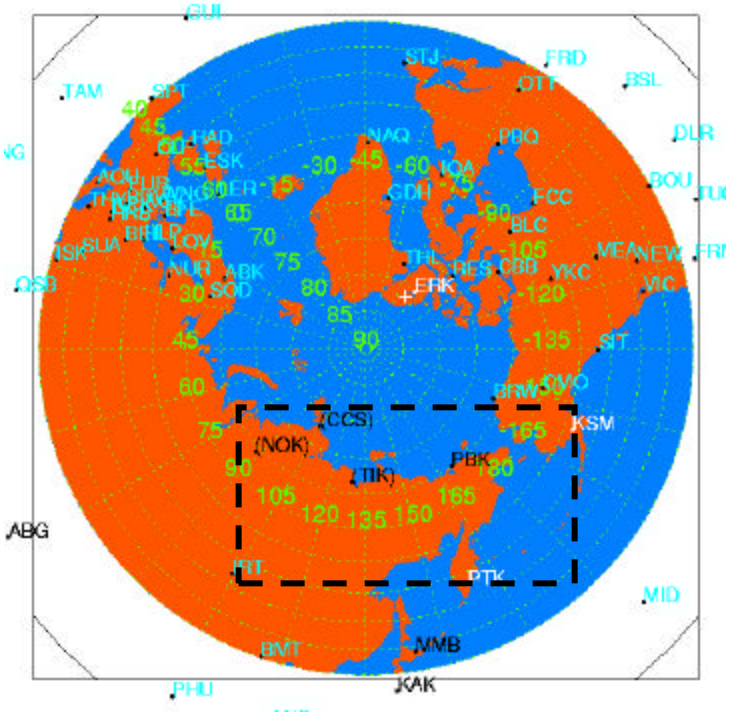




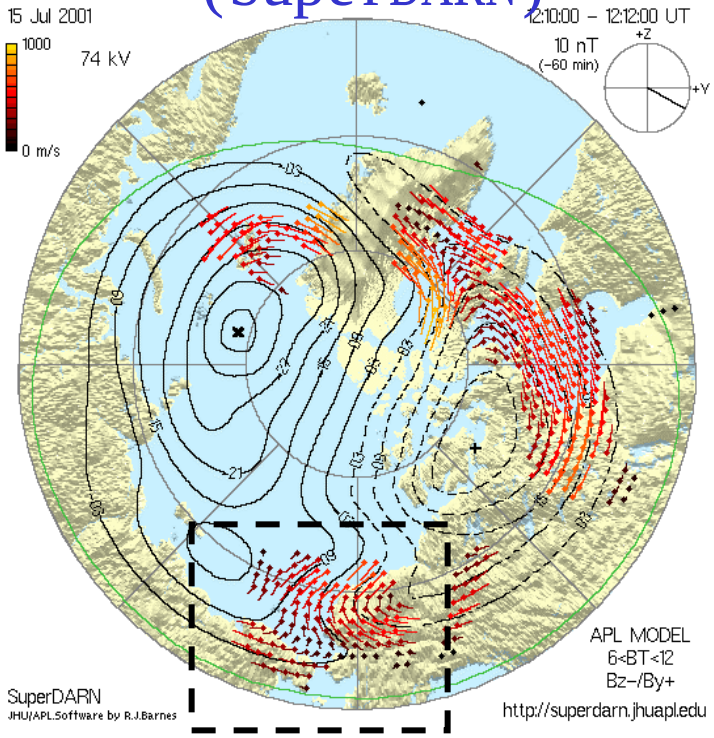
CME event obserbed by coronagraph onboard SOHO.

? ?
? ?
? ? ? (HiRAS)? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ? ? ? ? ? · ? ? ? ? ? ? ? · ?
? ? ? ? ? ? ? ? ?

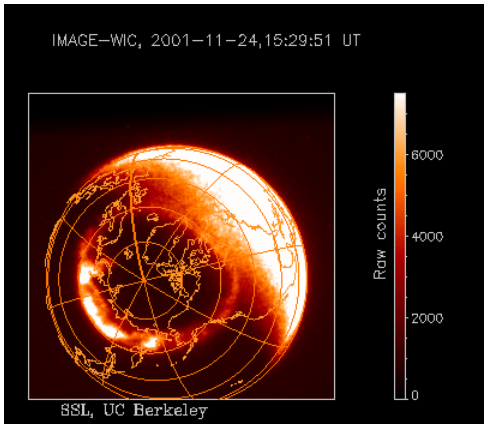
CRL magnetometer network & INTERMAGNET

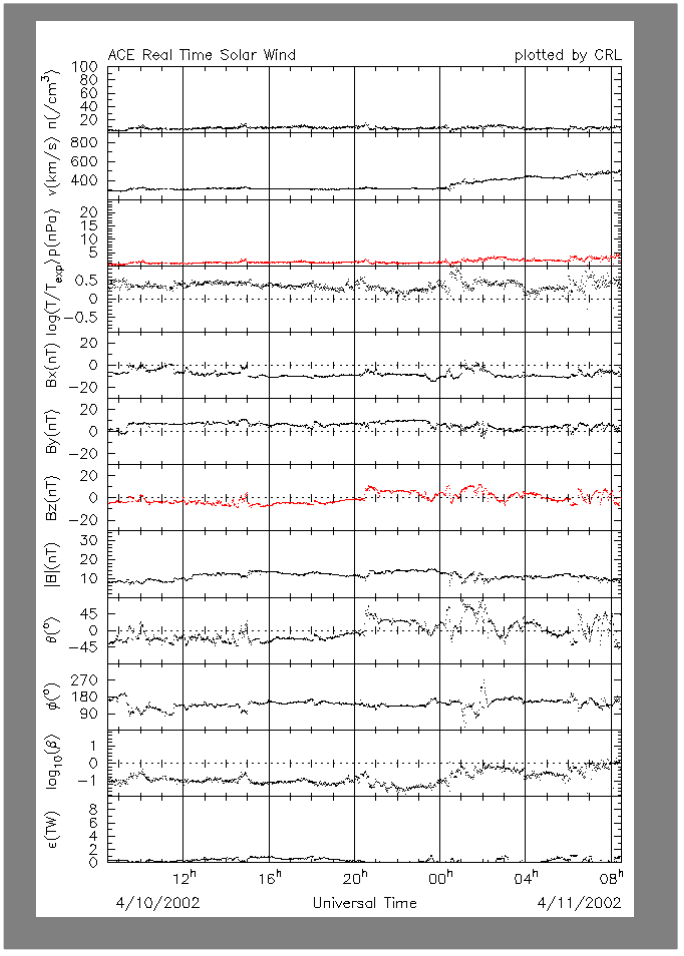


HF Radar Network (SuperDARN)



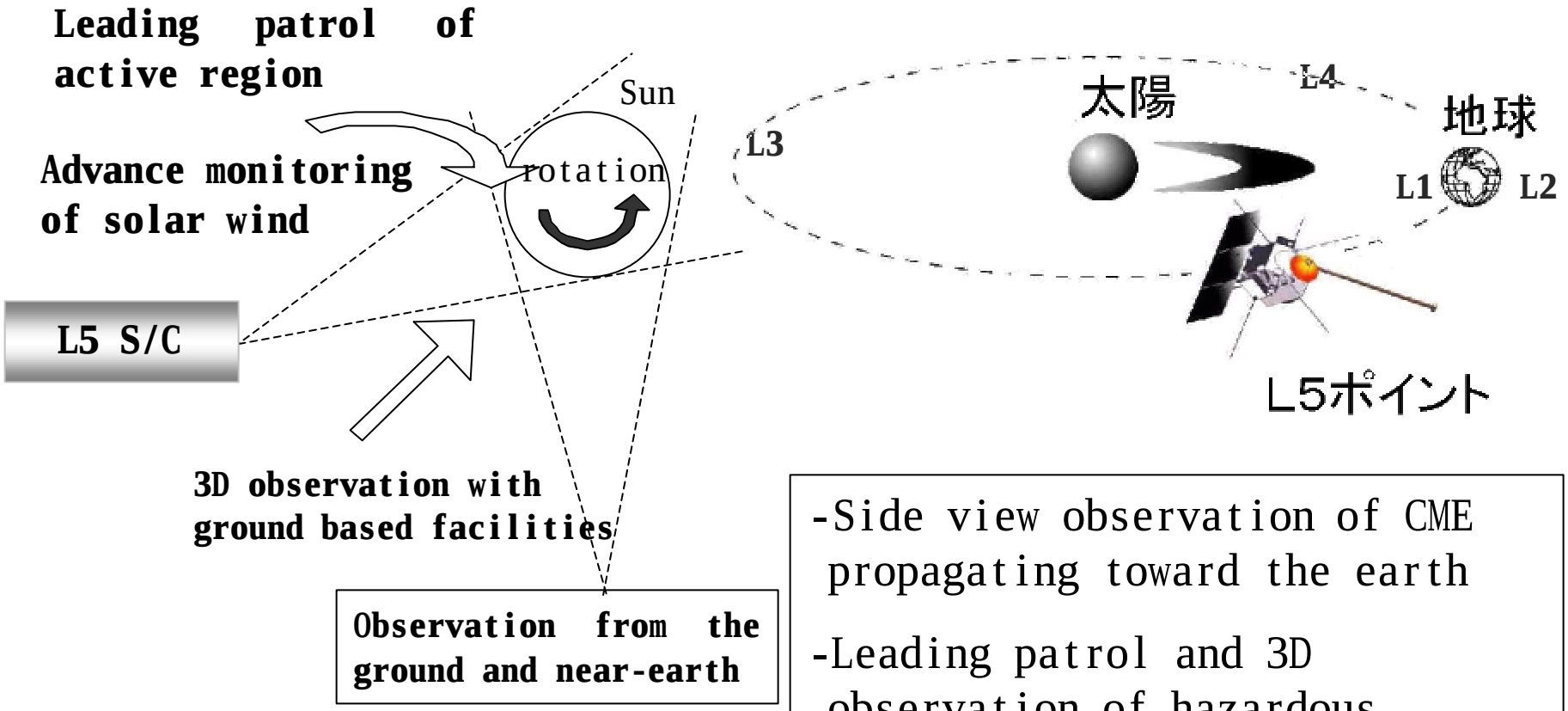
Real-time tracking of satellites (ACE/IMAGE)





2.Status of L5 mission Study

Outline of L5 Mission



- Side view observation of CME propagating toward the earth
- Leading patrol and 3D observation of hazardous sunspot group
- Advance detection and measurements of high speed stream

Launch Target:

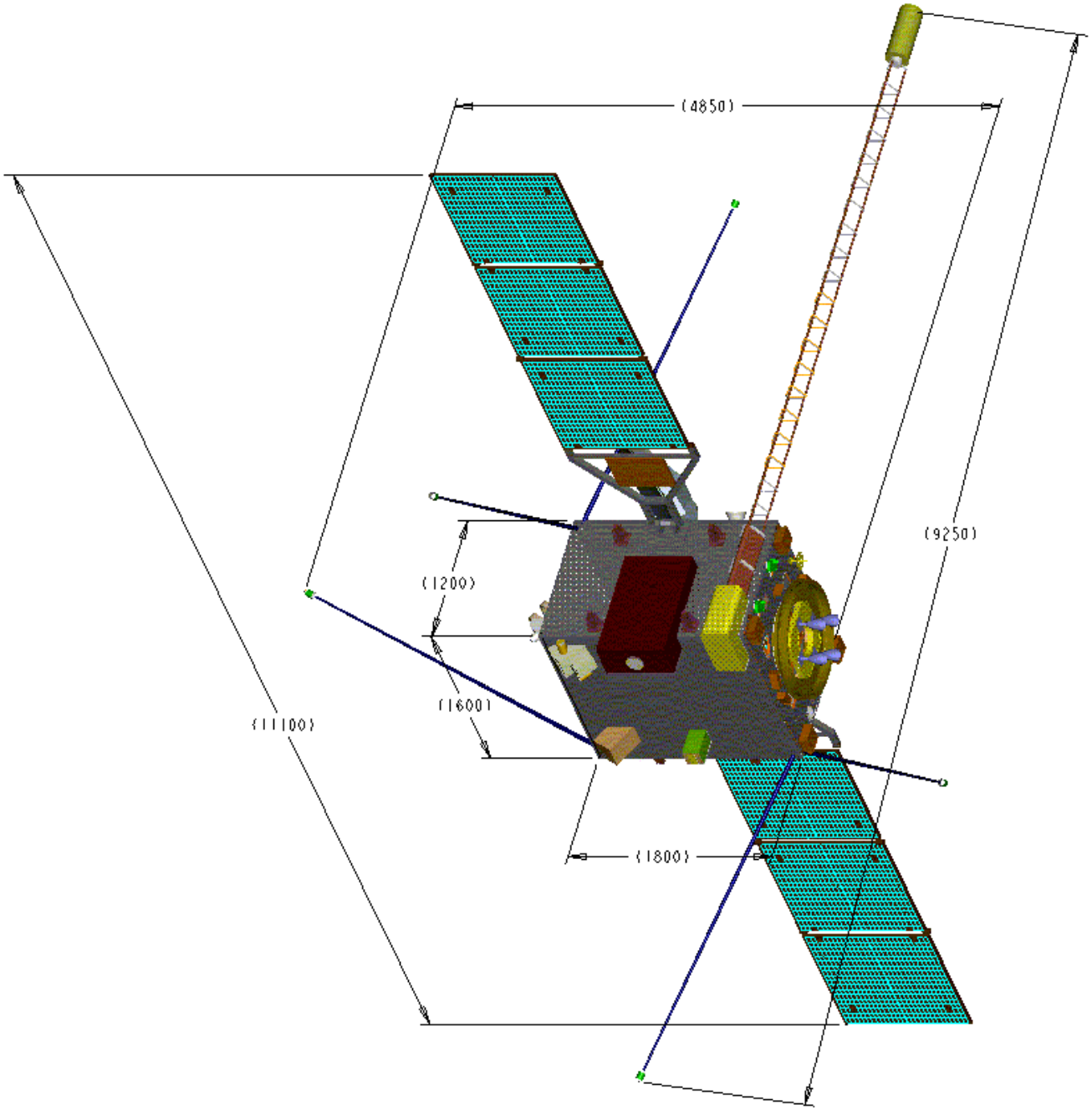
Next Solar Max. (2008-2013)

Mission Requirements

Candidates of Instruments	Mass (Kg)	Power (W)
WCI: Wide field Coronal Imager	10	20
HCI: High resolution Coronal Imager	40	40
SPA: Solar wind Plasma Analyzer	25	20
HPI : High energy Particle Instruments	15	15
MAG: Magnetometer	5	-
PWD: Plasma Wave Detector	10	10
MP: Mission Processor	15	20
(Mounting structures)	10	-
Mission Total	140	125

Attitude Stability : 0.1 arcmin. (TBD)

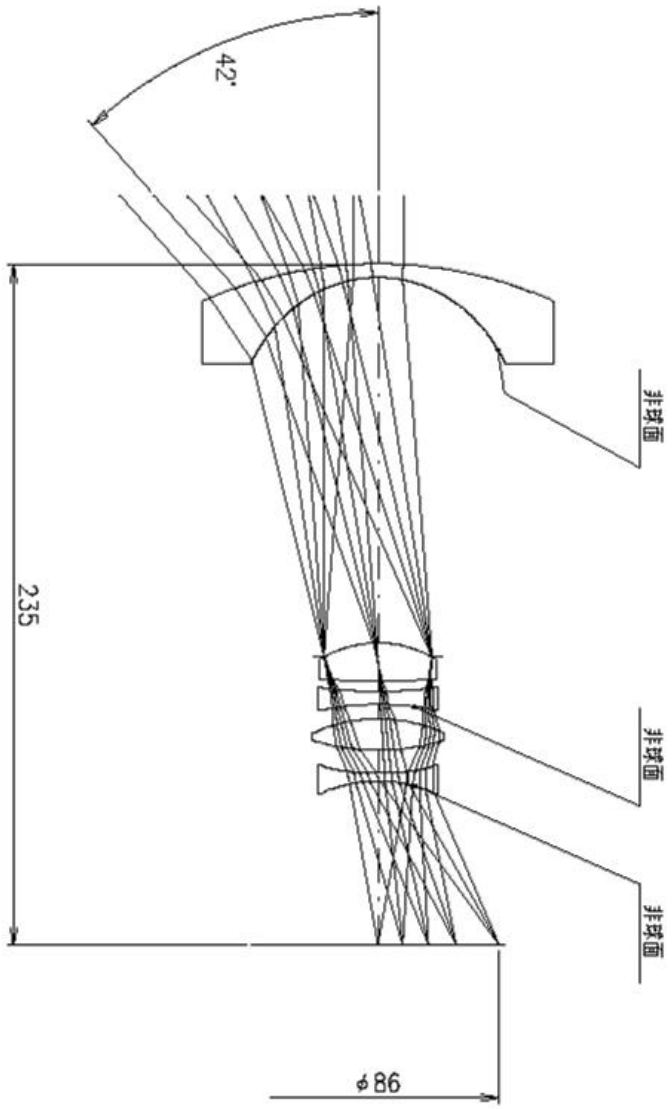
Mission lifetime : 4 yrs.


(4850)
(9250)
(1200)
(1600)
(11100)
(1800)

WCI Overview

Requirement

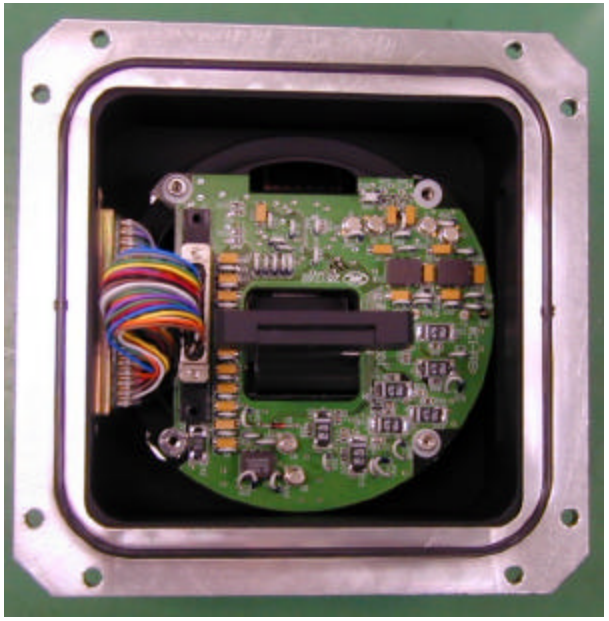
- Large dynamic range
  Target dynamic range = several thousands
  Background : CME Signal ~ 200:1
  -High SNR detector (1E4)
  -Extremely low scattered light optics
- Wide field of View
  - More than 60 degree to cover sun-earth space
  - trade with low scattered light

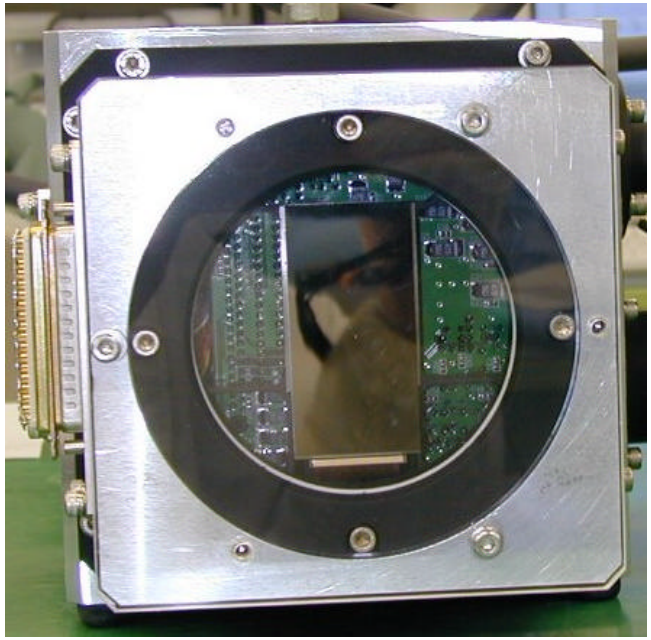


Preliminary Specification

Two camera (WCI-N, WCI-W)
f~ 55mm (WCI-W) , 110mm (WCI-N)
4K by 4K Mosaiced CCD
16bit AD , slow readout (100KHz),
cooling by radiator (~ 193K)
about 1000 pixels binnnig + frame integration

BBM of WCI





Mission Processor

Purpose and Requirement

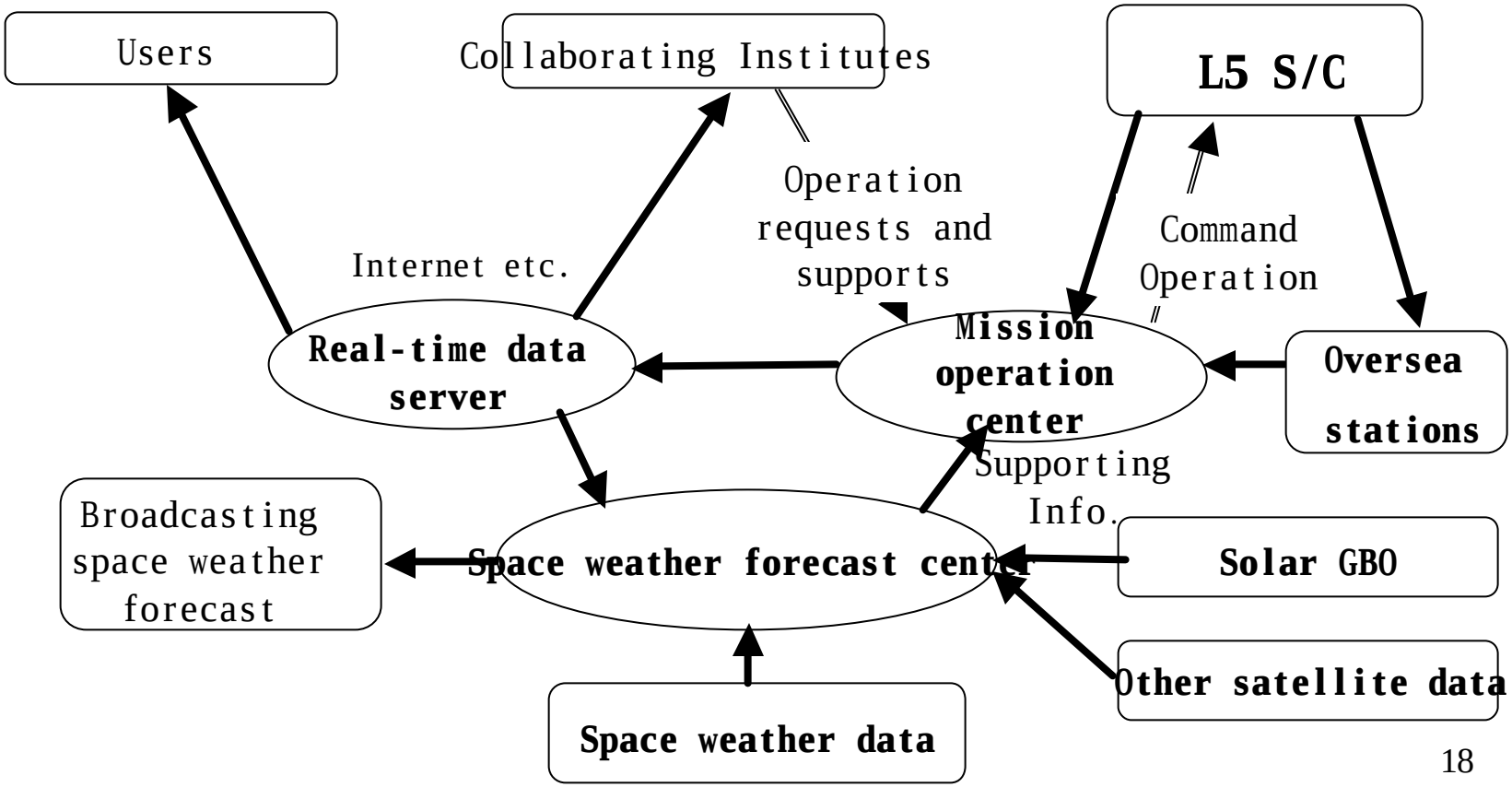
- Onboard data processing to reduce telemetry
  Onboard event detection from high cadence image and sequential data
- High performance image processing
  -Motion analysis
  -Autonomous subtraction of background, star, scattered-light, and radiation scratch on CCD.
- Control and data processing of all mission instruments

Preliminary Specifications

CPU	SH-4/7750 167MHz
Memory	2MByte SRAM + 8MByte DRAM
Data bus	MIL-STD-1553B (to S/C)
	Compact PCI base (Internal)
Redundancy	Partial redundancy with cold standby
Software	Commercial RTOS + Application
	(QNX and OS-9 are candidates)

Operational concept of L5 S/C with worldwide data network

R/T space weather data circulation by using state-of- the- art communication technology and infrastructure



3.Small Satellite Experiment in CRL and Space Weather

CRL started a study for new initiative for experimental mission using small spacecraft

-100-200Kg class standard bus

-Not only for space weather

-0.5 arcmin stability

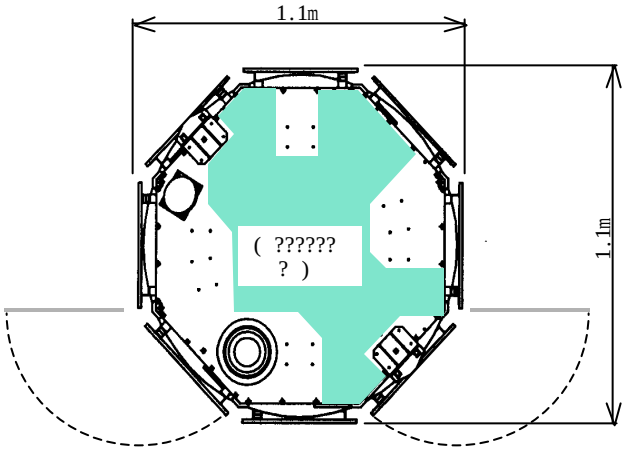
Current candidates

-Mission instrument demonstration for L5 mission

-orbital inspection experiment

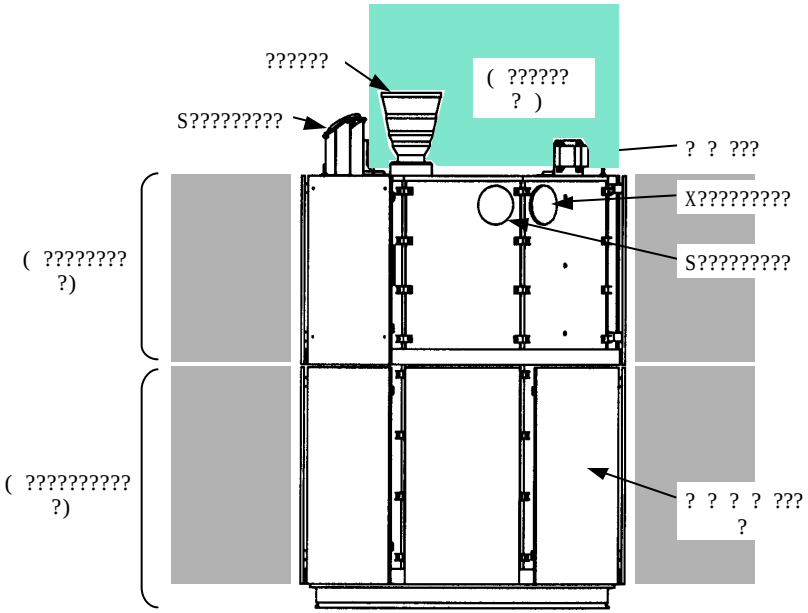
-inter-satellite optical communication experiment

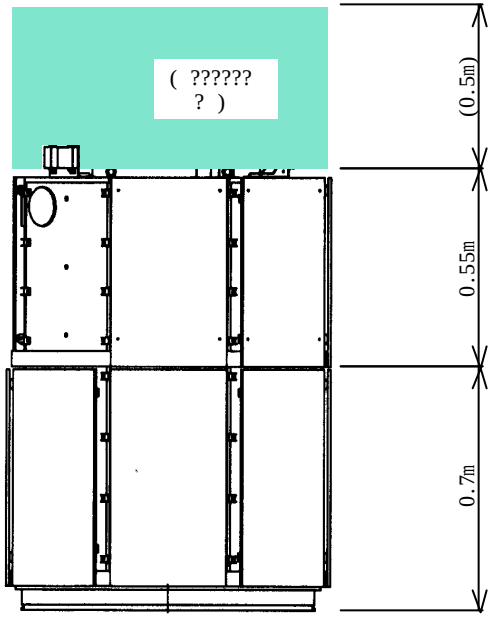
-space weather sensors



< ? ? >

	WET	DRY
? ? ? ? ? ?	50kg	
????	86kg	76kg
? ? ? ?	150kg	30kg
?	286kg	156kg





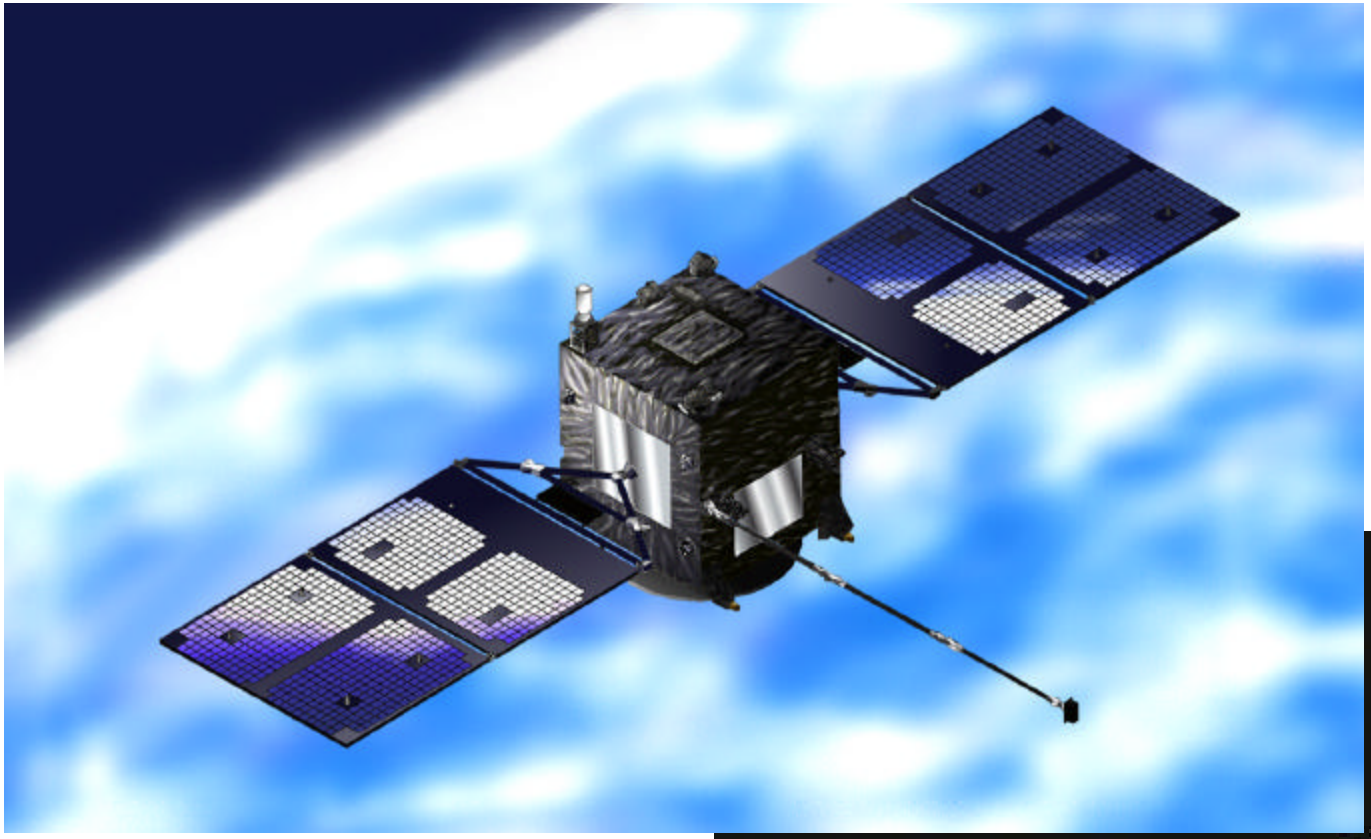
3-3

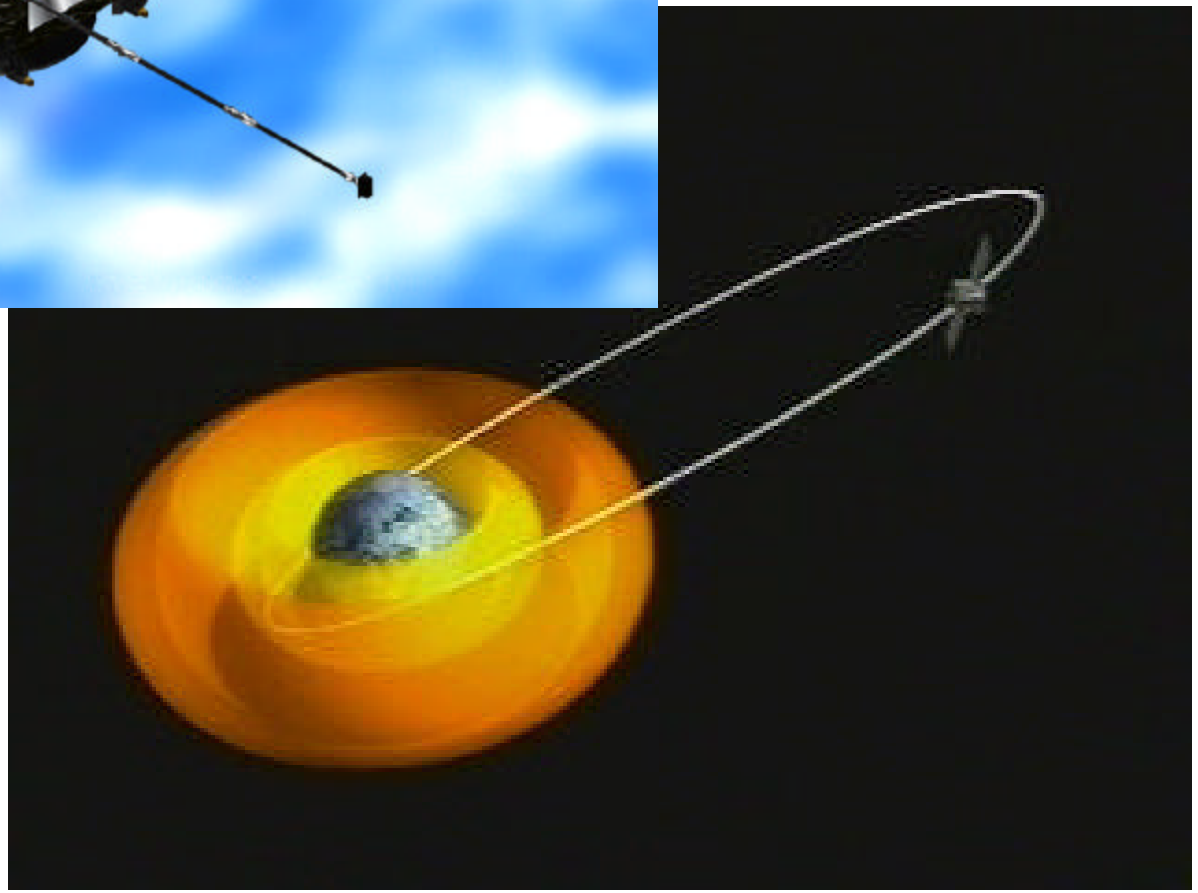
? 3.2.1- 1 ? ? ? ? ? ? ? ?

4.NASDA Space Environment Measurement

NASDA Radiation Measurement plan (2001-2005)

Satellite	MDS-1 (Mission Demonstration test Satellite-1)	ADEOS-II (Advanced Earth Observing Satellite II)	Data Relay Test Satellite (DRTS-W)	ALOS (Advanced Land Observing Satellite)	Japanese Experiment Module / Space Environment measurement device (JEM/SEDA)
Launch	FY2001	FY2002	FY2002	FY2004	FY2005
Orbit	Geostationary Transfer Orbit	Sun-synchronous Sub-recurrent Orbit	Geostationary orbit Longitude 90 ° East	Sun-Synchronous Sub-recurrent Orbit	?
Altitude	500 × 36000km	800km	35786km	700km	400km
Attitude Control	Spin stabilized (5rpm)	3-axis-stabilized	3-axis-stabilized	3-axis-stabilized	3-axis-stabilized
Incli nation	28.5 °	98 °	0 °	98 °	51.6 °
Period	-	101min	-	99min	-
Recur rent Period	-	4 days	-	45 days	-
Instru ments	SDOM, HIT	DOM	SDOM	LPT, HIT	LPT,HIT





MDS-1 (above) was launched into Geo-stationary Transfer Orbit(GTO) (500x36,000km) .

2-1. Standard DOse Monitor (SDOM)

SDOM measures the electron and proton flux, and consists of three Solid State Detectors (SSD) and one scintillator with two photo-multipliers (Fig.3). Deposit energy in each SSD is mainly used to distinguish particles and to evaluate its energy for lower energy particles while light emission in the scintillator is mainly used for higher energy particles.

Performance	electron 0.5~ 50 MeV proton 0.9~ 250 MeV alpha 6.7~ 270 MeV
Sampling	2 second / 8 second
Dimension	330 × 186 × 121 mm
Weight	9.0 kg

2-3. Heavy Ion Telescope (HIT)

HIT measures the flux of heavy ions from He to Fe, and consists of two Position-Sensitive Detectors (PSD) to evaluate incident direction of particles and sixteen Solid State Detectors (SSD) (Fig.5).

Single event Upset Monitor (SUM) is placed behind HIT's sensor, test sample of which are two 64-Mbit DRAM.

Performance	Li	6~ 40 MeV/ nucleon
	C	9~ 69 MeV/ nucleon
	O	11~ 83 MeV/ nucleon
	Si	15~ 114 MeV/ nucleon
	Fe	21~ 155 MeV/ nucleon
Dimension	414 × 574 × 230 mm (including magnetometer-electronics)	
Weight	27.7 kg (including magnetometer-electronics)	

5.Example of Space Weather Activity in STEL

REAL-TIME MAPPING OF IONOSPHERIC PARAMETERS